PRIVATE AND CONFIDENTIAL

RESEARCH DEPARTMENT

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THE BRITISH BROADCASTING CORPORATION

ENGINEERING DIVISION

RESEARCH DEPARTMENT

MEASUREMENTS ON SOME GERMAN DOMESTIC WIDEBAND U.H.F. RECEIVING AERIALS

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SUMMARY

The performance of some German u.h.f. receiving aerials has been investigated. Radiation patterns, beam widths, standing-wave-ratios and gains are given for the bands for which the aerials were designed.

1. INTRODUCTION

When regular television broadcast transmissions are commenced in the U.K. in Bands IV (470 to 582 Mc/s) and V (606 to 958 Mc/s), up to four transmissions, within a frequency band eleven channels (88 Mc/s) wide, may be broadcast from one transmitting site. If unnecessarily complex receiving installations are to be avoided wideband aerials will have to be used. In Germany this problem has been present for several years, and as a result aerials are now available which are claimed to maintain relatively high gains over a wide band of frequencies.

Since the design of such aerials entails a compromise between bandwidth on the one hand and gain and directivity on the other, it was decided to make measurements on four typical German aerials in order to obtain a measure of the performance obtainable in practice. All four were single Yagi aerials.

Similar tests were carried out some years ago on American domestic receiving aerials;[1] these included corner reflectors and panels of dipoles with reflectors. Most of these aerials were designed to cover the whole of the American u.h.f. band (470 Mc/s to 890 Mc/s).

2. DESCRIPTION OF AERIALS

2.1. Füba Type DFA 1 LM 13

This aerial, which is shown in Fig. 1, is designed for use in the frequency range 470 to 790 Mc/s. It is constructed entirely of anodized aluminium. The boom is square cross-section tube and the elements are curved strip. The weight including steel fixing brackets is about 2 lb (0·9 kg). The aerial has a single folded dipole as the driven element, two reflectors which are spaced apart in a plane at right angles to the direction of propagation, and ten directors, three of which are grouped very close to the driven element.

A balun transformer is fitted to the aerial, so that there is provision for connexion to either a 240-ohm balanced feeder or to a 60-ohm unbalanced feeder. The balun transformer is sketched in Fig. 2. In operation it is similar to the

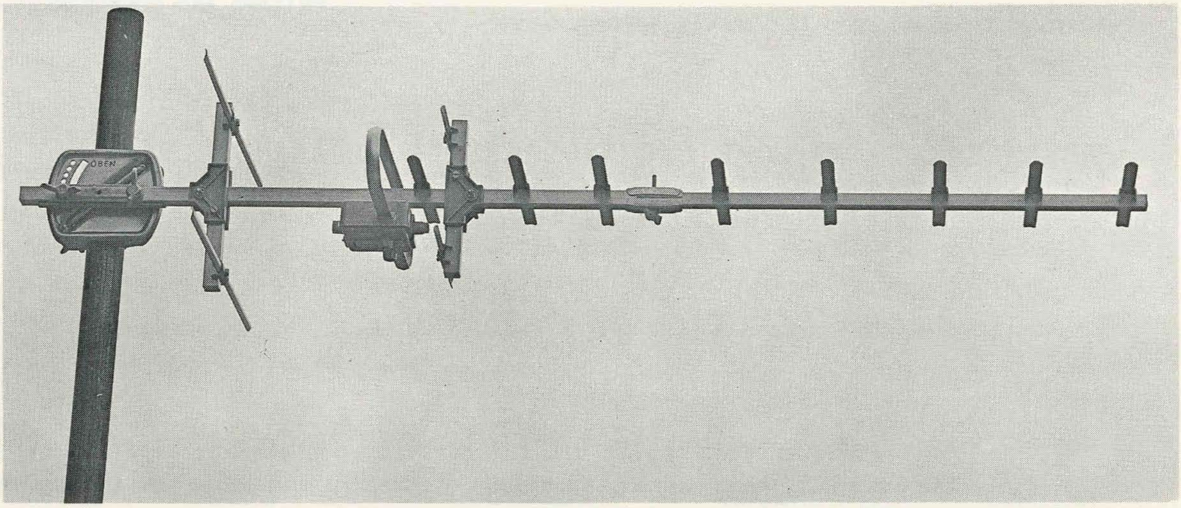

Fig. 1 - Füba, Type DFA 1 LM 13

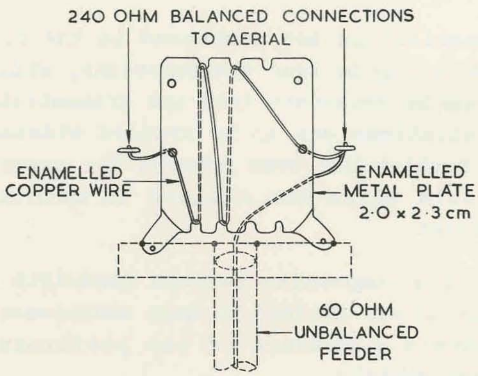

Fig. 2 - Füba, Balun Transformer

"bazooka" balun transformer which uses a half-wavelength of unbalanced line to perform the transformation. Here, however, the unbalanced line takes the form of an enamelled copper wire wound round an enamelled metal plate.

2.2. Füba Type DFA 1 L 11

This aerial, which is shown in Fig. 3, is designed for use in the frequency range 470 to 605 Mc/s. The materials, weight and type of construction are similar to those used for the type DFA 1 LM 13. The aerial has a single folded driven element, two reflectors which are spaced apart in a plane at right angles to the direction of propagation, and eight directors.

A balun transformer is fitted which is similar to that used on the type DFA 1 LM 13.

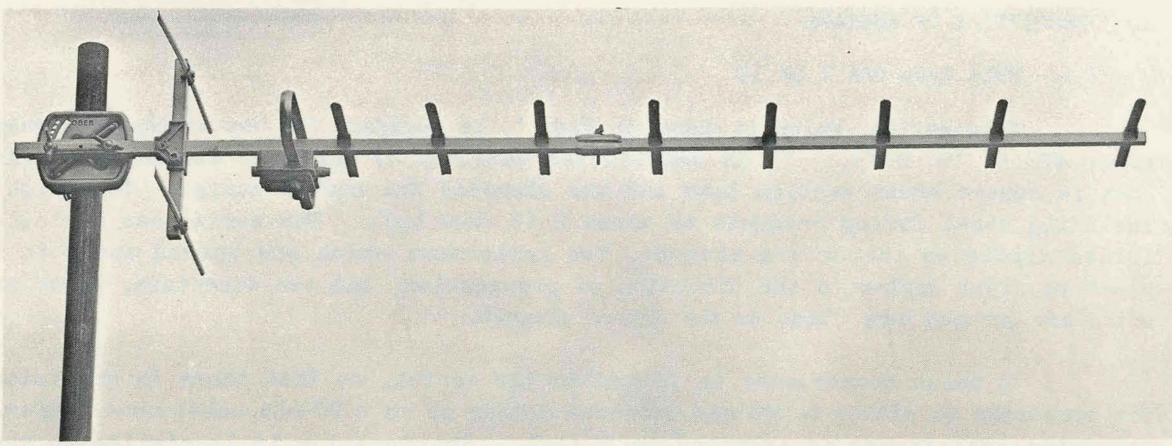

Fig. 3 - Füba, Type DFA 1 L 11

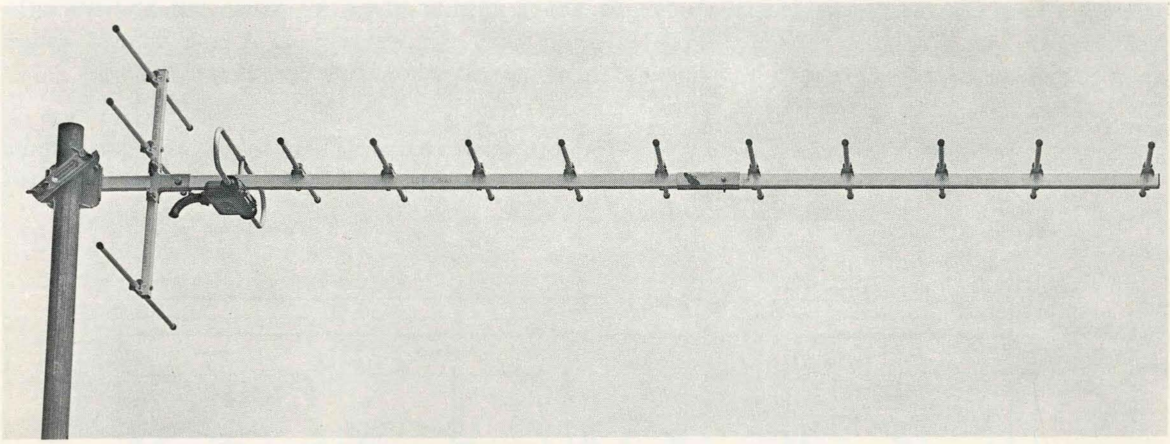

Fig. 4 - WISI, Type EB 10

2.3. Wilhelm Sihn (WISI) Type EB 10

This aerial, which is shown in Fig. 4, is designed for use in the frequency range 503 to 573 Mc/s. It is constructed entirely of anodized aluminium. The boom is square cross-section tube and the elements are strips bent to form tubes. The weight including steel fixing clamps is about 2·2 lb (1·0 kg). The aerial has a single folded driven element, three reflectors which are spaced apart in a plane at right angles to the direction of propagation, and ten directors.

A "bazooka" type balun transformer comprising a length of small diameter coaxial line is fitted. This provides for connexion to either a 240-ohm balanced feeder or to a 60-ohm unbalanced feeder.

2.4. Hirschmann Type FESA 13 M

This aerial, which is shown in Fig. 5, is designed for the frequency range 470 to 605 Mc/s. The materials and type of construction are similar to those of

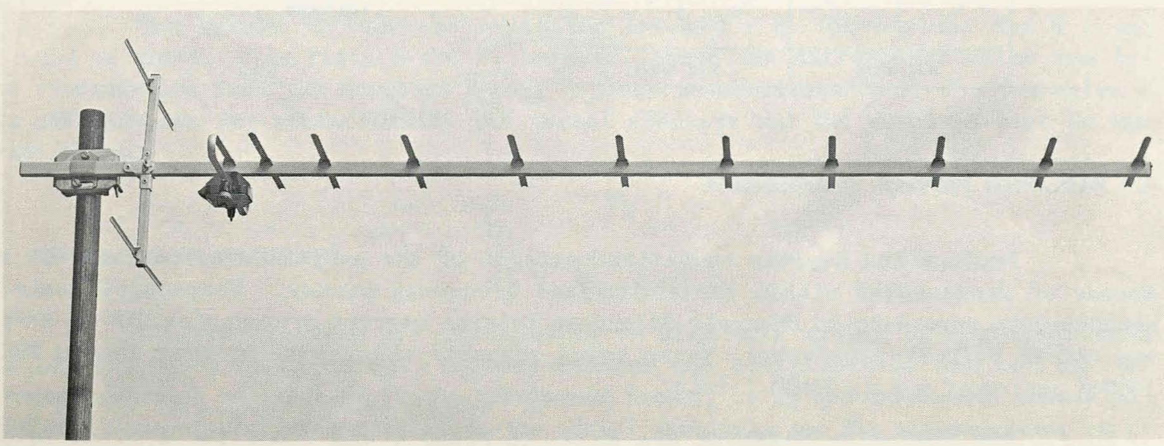

Fig. 5 - Hirschmann, Type FESA 13 M

the Füba aerials. The weight including a steel fixing clamp is about 1·8 lb (0·8 kg). The aerial has a single folded driven element, two reflectors which are spaced apart in a plane at right angles to the direction of propagation and ten directors.

A "bazooka" type balun transformer comprising a length of low-impedance balanced feeder is fitted; this provides for connexion to either a 240-ohm balanced feeder or to a 60-ohm unbalanced feeder.

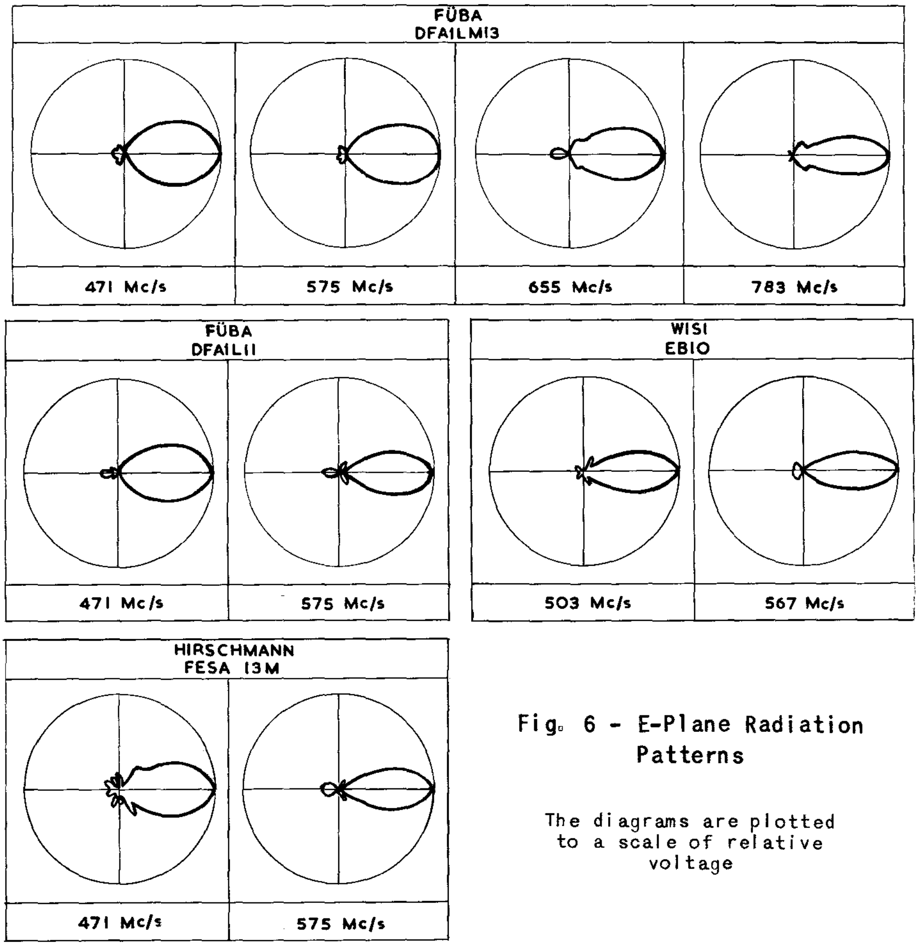

Fig. 6 - E-Plane Radiation Patterns

The diagrams are plotted to a scale of relative voltage

3. RADIATION PATTERN MEASUREMENTS

E-plane and H-plane radiation patterns of the aerials were measured at a number of frequencies within their designed frequency bands. Where applicable, measurements were made in Channels 34 and 44 (vision carrier frequencies 575·25 Mc/s and 655·25 Mc/s respectively), these being channels which will be used in the BBC 1962-3 series of u.h.f. field trials.

The radiation patterns are shown in Figs. 6 and 7 and the E-plane beam widths (to half-power points) and maximum levels of backward radiation (outside $\pm$ 90°)

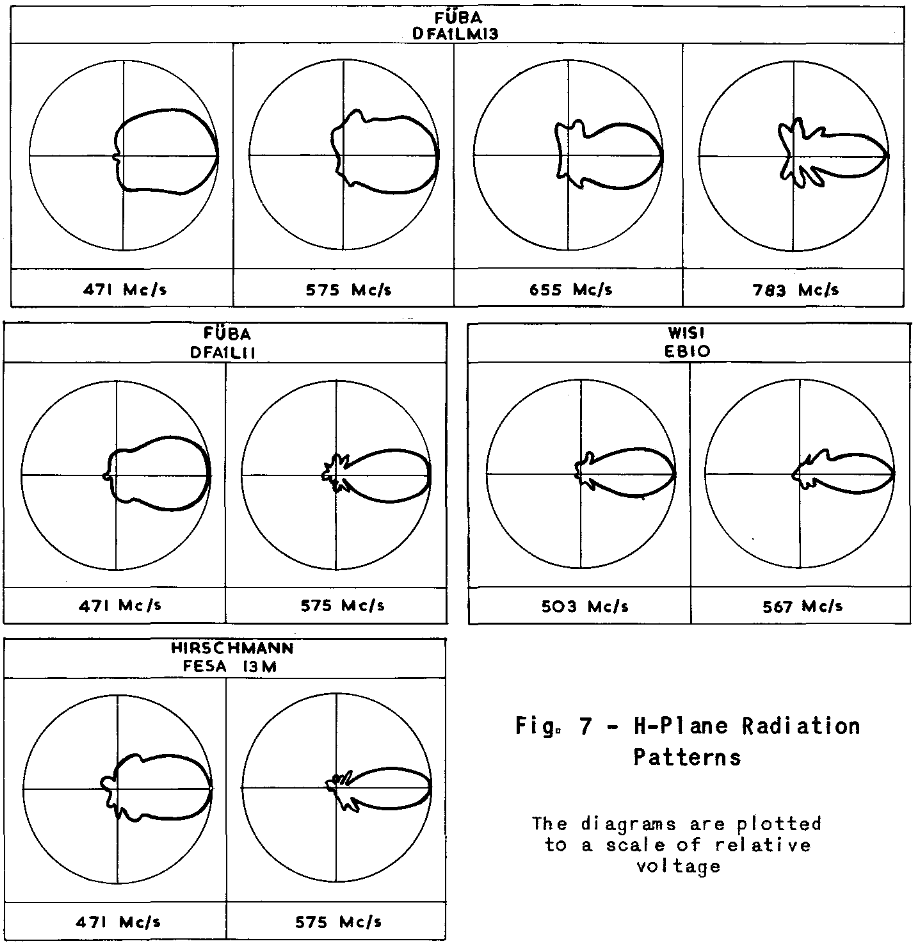

Fig. 7 - H-Plane Radiation Patterns

The diagrams are plotted to a scale of relative voltage

are summarized in Table 1. The measured beam widths are similar to those given in the makers' catalogues but the levels of backward radiation are, in several cases, about 9 dB higher than the undefined back-to-front ratios given by the makers.

The levels of backward radiation (at 180°) in the E-plane and H-plane should be equal. In Figs. 6 and 7, however, there are differences which are due to re-radiation from the downlead during H-plane measurements when, for convenience in carrying out the measurements, the aerial elements and the downlead were in the same plane.

4. IMPEDANCE MEASUREMENTS

All four aerials are intended to be used with either 60-ohm unbalanced or 240-ohm balanced feeders. For convenience the admittance of the aerials was measured through a length of 75-ohm unbalanced feeder, using the unbalanced connexion. The admittances were referred back to the aerial terminals and the standing-wave-ratio calculated when connected to a 60-ohm feeder. The results are shown in Fig. 8.

TABLE 1

E-PLANE BEAM WIDTHS TO HALF-POWER POINTS AND MAXIMUM LEVELS OF RADIATION OUTSIDE ± 90°

	471 Mc/s	503 Mc/s	567 Mc/s	575 Mc/s	655 Mc/s	783 Mc/s
Füba DFA 1 LM 13	± 29° -16 dB			± 27° -19 dB	± 24° -15 dB	± 17° -22 dB
Füba DFA 1 L 11	± 26° -16 dB			± 19° -15 dB		
WISI EB 10		± 20° -24 dB	± 18° -19 dB			
Hirschmann FESA 13 M	± 25° -15 dB			± 17° -15 dB		

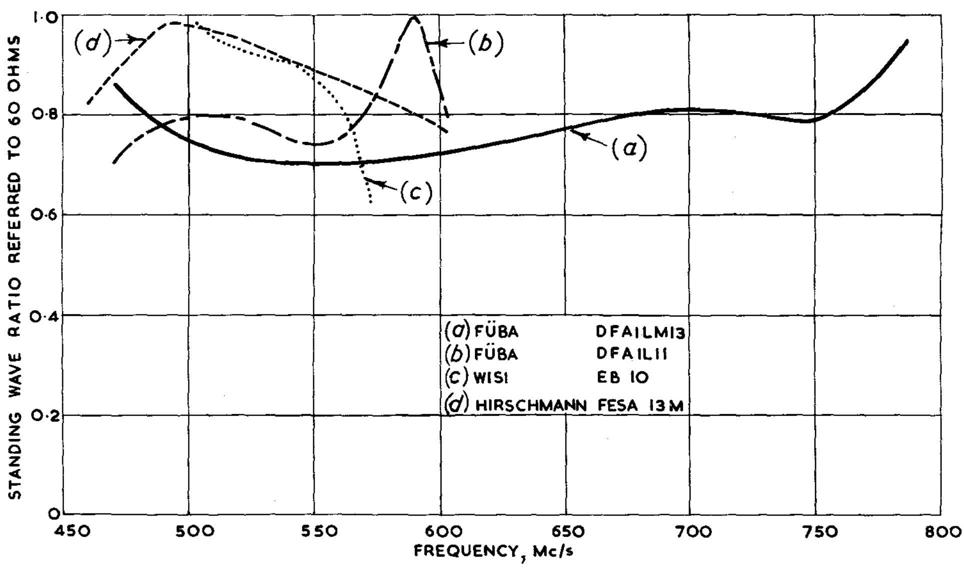

Fig. 8 - Standing-Wave Ratios when Connected to 60-ohm Unbalanced Feeders

5. GAIN CALCULATIONS

The approximate intrinsic gain of each aerial relative to that of a $\lambda/2$ dipole in free space was obtained from the H-plane radiation patterns by a process of graphical integration. This method does not give an exact answer, in so far as it assumes that the elements of the aerials are coplanar. For these aerials, however, the error is not likely to be in excess of 1 dB.

The effective gain of each aerial, which is given in Table 2, is equal to its intrinsic gain minus the loss due to mismatch when connected to a 60-ohm feeder. Within the limits of accuracy imposed by the method of calculation the values are similar to those given in the makers' catalogues.

TABLE 2

EFFECTIVE GAINS WHEN CONNECTED TO 60-ohm FEEDER (dB)

	471 Mc/s	503 Mc/s	567 Mc/s	575 Mc/s	655 Mc/s	783 Mc/s
Füba DFA 1 LM 13	6·7			7·0	8·1	9·4
Füba DFA 1 L 11	8·1			10·8		
WISI EB 10		11·0	11·7			
Hirschmann FESA 13 M	8·2			11·7		

6. CONCLUSIONS

Four German commercially produced u.h.f. receiving aerials have been tested in respect of radiation pattern, impedance and gain. The aerials were all single-tier Yagis and were designed to cover a number of adjacent television channels.

The Yagi aerial is usually considered to be a narrow-band aerial both in terms of intrinsic gain and impedance, but the results of these tests demonstrate that large bandwidths can be achieved under normal production conditions without undue complexity.

At those frequencies at which radiation patterns were measured the level of unwanted sidelobes in the E-plane was low. This means that the aerials are suitable for the reception of horizontally polarized signals in the presence of re-radiating obstacles at or near ground level. In some cases, high levels of sidelobes in the H-plane were measured, but since vertically polarized u.h.f. transmissions are not used in Germany this is not very important. High sidelobe levels in the H-plane may, however, give rise to a slight increase in aircraft flutter for horizontally polarized signals.

The values of effective gain given in Table 2 assume connexion to a 60-ohm unbalanced feeder, this being standard in Germany. The maximum mismatch loss measured within the design frequency band was about 0·14 dB. If a 75-ohm British standard unbalanced feeder were used with the same aerials the corresponding maximum loss would be about 0·36 dB.

7. REFERENCE

1. "Measurements on Some American Domestic Receiving Aerials for the U.H.F. Bands", Research Department Report No. E-066, Serial No. 1958/25.

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